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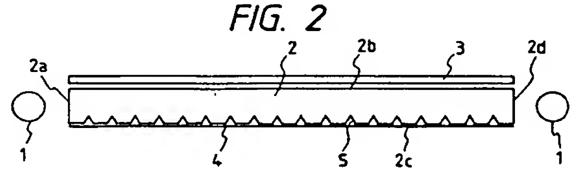
(54) **Surface light source device.**

(57) A surface light source device which comprises a light-conducting member consisting of a sheet of transparent material, a linear light source disposed adjacent to an edge surface of the light-conducting member, a diffusion plate disposed on a front surface of the light-conducting member and a reflective plate disposed on a rear side of the light-conducting member. The rear surface of the light-conducting member has depressions or projections. These depressions or projections have rough surfaces. By selecting the shape of the depressions or projections, and controlling the roughness of the rough surfaces, an enhanced uniform brightness distribution is provided.

FIG. 2



EP 0 544 332 A1

Background of the Invention

a) Field of the Invention:

This invention relates to a surface light source device to be used as a backlight for a liquid crystal display unit.

b) Description of the Prior Art

Figure 1 shows a conventional surface light source device that has a light-conducting member. This device comprises a linear light source 1, such as a cold-cathode fluorescent tube, a light-conducting member 2 that has an edge surface of incidence 2a disposed adjacent the light source 1, a diffusion plate 3 that is located on or adjacent a front surface 2b (a top surface in Figure 1) of the light-conducting member 2, and a reflective surface that is disposed adjacent a rear surface 2c (a lower surface in Figure 1) of the light conducting member 2. In this surface light source device, an incident light from the source 1 is directed toward the edge surface of incidence 2a of the light-conducting member 2. The light-conducting member 2 conducts the light toward a rearward edge surface 2d by total internal reflection from the surfaces 2b and 2c.

In the conventional device, however, the surface 2c of the light-conducting member 2 is provided with either a roughened surface or spots 2e formed by painting to scatter part of the conducted light, in such a way that part of the light, while travelling toward the surface 2d, spreads out from the surface 2b without being reflected by the surface. Thus, in the surface light source device of Fig. 1, when the rear surface 2c of the light-conducting member 2 has a rough surface or forms an array of spots 2e, as shown in Fig. 1, so that, while the incident light from the source 1 is advanced passing through the light-conducting member 2, part of this light spreads out from the surface 2b and then passes through the diffusion plate 3 to form a diffused light, which is available for use as a surface light source.

In this surface light source device, it is necessary to ensure that the diffused light that has passed through the diffusion plate 3 should appear uniformly over an entire surface of the diffusion plate 3.

Also, because this surface light source device can be used, for example, as a back-light of a liquid crystal display, this requires the diffused light to be bright enough for such an application. Thus, the surface light source device is provided with means to increase the brightness.

Typical surface light source devices of the prior art that have means to increase the brightness, are disclosed in Japanese Patent Kokai Publication No. 3-189679A and Japanese Utility Kokai Publication No. 3-31782A. Like the device of Fig. 1, each of these devices comprises a light source, a light-conducting member, a diffusion plate and a reflective plate. The surface 2c of the light-conducting member 2, which is opposite to the front or emitting surface 2b, i.e. the surface 2c adjacent to the reflective surface 4, forms a large number of minute pyramids which are arranged concavely or convexly to increase the brightness on the diffusion plate. Various sizes of these pyramids are arranged according to the area chosen to produce a uniform brightness distribution.

These prior art devices, however, have a problem in that, although it is possible to increase the brightness if the pyramid has a relatively large surface area, it is difficult to produce a uniform brightness distribution on the diffusion plate 3. Also, the pyramid formed on the light-conducting member has a disadvantage in that the light will shine at their corners.

Summary of the Invention

An object of this invention is to provide a surface light source device comprising a planar light-conducting member of transparent material, a linear light source which is located adjacent at least one edge surface of the light-conducting member, a diffusion plate located on the front surface of the light-conducting member, and a reflective surface disposed on or adjacent the rear surface of the light-conducting member, characterized that the rear surface of the light-conducting member has a multiplicity of minute projections or depressions formed thereon and that these projections or depressions have rought surfaces.

The rough surface has a multiplicity of microscopic projections and depressions, and resembles the face of a sand-paper in a configuration. The light reflected by, or transmitted through, the rough surface is scattered as a diffused light. The greater the roughness of the rough surface is, the greater the extent of the diffusion of the scattered light is. The fact that the roughness is great means that, in considering the depth and the width of both the microscopic projection and depression, and the pitch of the projections and depressions in their vertical cross-section, when both the width and the pitch are constant, the depth is great, when both the depth and the pitch are constant, the width is great, and when both the depth and the width are constant, the pitch is small.

Another object of this invention is to provide a surface light source device wherein various shapes and sizes of minute projections or depressions are formed on the rear surface of the light-conducting

member, each of these projections or depressions having a rough surface.

A still another object of this invention is to provide a surface light source device wherein the rear surface of the light-conducting member has continuous corrugations, each of these corrugations having a rough surface.

Brief Description of the Drawings

Fig. 1 is a sectional view of a surface light source device of the prior art.

Fig.2 is a sectional view of a first embodiment of this invention.

Fig. 3 is an enlarged section view of a light-conducting member used in the first embodiment.

Fig. 4 is a section view of a second embodiment of this invention.

Fig. 5 is an enlarged section view of a light-conducting member used in the second embodiment.

Fig. 6 is an enlarged section view of a light-conducting member used in a third embodiment of this invention.

Fig. 7 is a sectional view of a variation of a light-conducting member used in the third embodiment.

Fig. 8 through Fig. 10 are views of variants of a light-conducting member shown in Fig. 5 through Fig. 7, respectively.

Fig. 11 is an enlarged section view of a light-conducting member used in a fourth embodiment of this invention.

Fig. 12 is an enlarged section view of a light-conducting member used in a fifth embodiment of this invention.

Fig. 13 is an enlarged section view of a light-conducting member used in a sixth embodiment of this invention.

Fig. 14 through Fig. 16 are views of variants of a light-conducting member shown in Fig. 11 through Fig. 13, respectively.

Fig. 17 is a sectional view of a seventh embodiment of this invention.

Fig. 18 is a view of a variation of the seventh embodiment of this invention.

Fig. 19 is a sectional view of an eighth embodiment of this invention.

Fig. 20 is a view of the light-conducting member as viewed from its top (from its light-emitting side).

Figs. 21 and 22 are views of the curves of corrugations in the light-conducting member used in the eighth embodiment of this invention.

Fig. 23 through Fig. 29 are views of variants of the light-conducting member used in the eighth embodiment of this invention, respectively.

Fig. 30 is a view showing the configuration of a metal mold with rough surfaces that is used to form a light-conducting member having corresponding rough surfaces.

Fig. 31 is a view of a pattern of rough surfaces.

Detailed Description of the Preferred Embodiments

Figure 2 is a sectional view of a first embodiment of a surface light source device of this invention. The device of Fig. 1 comprises a light source 1, a light-conducting member 2, a diffusion plate 3 and a reflective plate 4. A pair of the light source 1 are located adjacent to both ends 2a, 2d of the light-conducting member 2. A surface 2c of the light-conducting member 2, which is opposite to an emitting surface 2b, has a multiplicity of small depressions 5 formed thereon. Each of these depression a has a rough surface.

In this first embodiment, because the surface 2c of the light-conducting member 2 has a large number of depressions 5, the direction of total reflection from the surface 2c will be altered by the depressions 5. Thus, if the size, shape and position of the depression 5 is appropriately selected, it is possible to produce a relatively uniform brightness distribution on the diffusion plate 3. Further, due to the rough surface 11 formed on the depression 5, it is possible to make more uniform the brightness distribution.

Figure 3 is an enlorged view of a light-conducting member 2 for use in the first embodiment. This light-conducting member 2 has a number of conical-, or pyramidal-shaped depressions 5 formed thereon. If a multiplicity of conical or pyramidal depressions are formed and their size, shape and position is appropriately selected, it is possible to provide a uniform brightness distribution on the surface light source device.

As shown in Fig. 2, this embodiment has a pair of light sources. However, if four units of light sources are used, one each on the surface 2b on four sides of the square-, or rectangular-shaped light-conducting member 2, it is possible to enhance the brightness of a surface light source device. Alternatively, only one light source may be adequate for a certain need.

In this first embodiment, by increasing the number of light sources used and providing a light-conducting member with depressions, it is possible to provide a bright surface light source device. Also, by appropriately selecting the size etc. of the depressions, it is possible to produce a uniform brightness distribution.

This embodiment has a disadvantage in that, as the depressions of the light-conducting member 2 have conical or pyramidal shape, only their apex or corners etc. will appear recognizably bright with

emitted light.

Throughout this embodiment as well as other embodiments that will be described hereafter, this invention has a major feature in providing depressions on the rear surface of the light-conducting member 2, as well as in the shapes etc. of these depressions. Thus, to enable clear understanding, these depressions and their shapes are shown in expanded form in the drawings. In practice, however, the depression or projection has a size of about 0.1 to 1 mm.

Figure 4 is a sectional view of a second embodiment of this invention. This embodiment has a light source 1, a light-conducting member 2, a diffusion plate 3 and a reflective plate 4, in the same configuration as that of the surface light source device of Fig. 2. In this second embodiment, however, as shown in Figure 5, a surface 2c has hemispherical depressions 5 formed thereon. These depressions 5 are formed in a pattern such that the radius of curvature becomes the smallest for those which are located close to the light source 1 and gradually increases along the length of the surface 2c. In this way, by providing a multiplicity of hemispherical depressions that have differences in the radius of curvature, it is possible to make uniform a brightness distribution on the diffusion plate 3, as can be achieved in the first embodiment. Also, the problem of a local shining can be overcome as hemispherical depressions are provided.

In this embodiment, depressions on the surface 2c may be formed in a pattern such that they will have the increased depth along its length as they lie farther from the light source 1, with the most shallow ones close to the light source 1.

Figure 6 is an enlarged sectional view of a third embodiment of this invention wherein a light-conducting member 2 has differently shaped depressions 6, which are of cylinderical form. The depressions 6 have the increased dimensions as they lie farther apart from the light source 1.

In this embodiment, while Figure 6 shows depressions 6 having a change in the length t_1 as well as depth t_2, it is possible to achieve the same effect by changing either the length t_1 or the depth t_2 alone.

Figure 7 is a sectional view of a variation of the third embodiment of the light-conducting member, shown in Figure 6, wherein the light-conducting member 2 has depressions of cylindrical form, whose innermost surface 6a is spherical.

Also, as shown in Figures 8, 9 and 10, a surface 2c of the light-conducting member 2 may have projections in place of depressions. These projections may be spherical, as shown in Figure 8, or cylindrical, as shown in Figures 9 and 10. These projections have the increased dimensions as they lie farther from the light source 1.

In this third embodiment, to make more uniform the brightness distribution on the diffusion plate 3, the projections or depressions of the light-conducting member 2 should preferably have rough surfaces on their surfaces 5a, 6a, 5b, 6b, respectively. Further, the roughness of the surfaces should preferably become greater as they lie farther from the light source 1.

Figures 11 through 13 are enlarged views of a light-conducting member for use in a fourth embodiment of this invention. In the first, second and third embodiments, the depressions used therein are of conical, pyramidal, or hemispherical form, etc.. By contrast, the depressions shown in Figs. 11 to 13 may be of any shape consisting of curves, and each of the depressions has a rough surface. Further, in Figures 12 and 13, the depressions have various sizes and depths. These depressions have different degrees of roughness. Thus, it is possible to cause the light to be uniformly emitted from the entire surface 2b.

In the fourth embodiment of Figure 11, a surface 2c of the light-conducting member 2 has depressions of the same shape and size that are equally spaced. This embodiment has a depression 10 with a rough surface 11 formed thereon. Due to the distribution of these rough surfaces 11, the light emitted from the surface 2b becomes uniform throughout the surface 2b, thereby providing a uniform brightness distribution of a diffuse light that has passed through the diffusion plate 3. More particularly, the roughness of the surfaces 11 becomes greater as they lie farther from an edge surface of incidence 2a.

In this fourth embodiment of Figure 11, because the surface 2c of the light-conducting member 2 has a multiplicity of depressions 10, the light that is incident on the edge 2a is reflected from the depressions 10 and then emitted from the emitting surface 2b. The emitted light passes through the diffusion plate 3 to form a diffuse light. The light that is incident on the surface 2a, but that is transmitted through the depressions 10 is reflected from the reflective plate 4 and re-enter into the light-conducting member 2. The reflected light is then emitted from the emitting surface 2b and passes through the diffusion plate 3 to form a diffuse light. In this case, the light emitted from the light-conducting member 2 tends to have the declining intensity with respect to its areas lying farther from the edge surface of incidence 2a. In this fourth embodiment having a distribution of depressions mentioned above, it is possible to provide a uniform brightness distribution.

Figure 12 is a sectional view of a fifth embodiment of a light-conducting member for use in this invention, wherein depressions 12 have different

sizes in different areas. More particularly, while having the same depth, the depressions 10 have the increased width as they lie farther from the edge surface of incidence. Due to the distribution of depressions as noted above, this embodiment provides a substantially uniform brightness distribution. In this embodiment, each of the depressions have substantially the same roughness.

Figure 13 is a sectional view of a sixth embodiment of a light-conducting member for use in this invention, wherein the light-conducting member 2 has depressions 13 with different depths in different areas. More particularly, depressions 13 have the increased depths as they lie farther from the edge surface of incidence. In this way, as with the light-conducting member of Figure 12, it is possible to cause the light to be uniformly emitted from the entire emitting surface 2b.

Figures 14, 15 and 16 are views of variants of the light-conducting member 2 of Figures 11, 12 and 13, wherein depressions 10, 12 and 13 are replaced by projections 10', 12' and 13', respectively. The light-conducting member 2 of Figure 14 has each of projections of the same size and shape. Also, the protrusions have different roughness in different areas, as in Figure 11. By contrast, the light-conducting member of Figures 15 and 16 have projections 12' or 13' of different sizes in different areas.

In the above-mentioned embodiments, it must be noted that the surface 2c of the light-conducting member 2 has depressions or projections each of which is symmetrical with respect to its vertical center line.

Figure 17 is a sectional view of a seventh embodiment of a light-conducting member, wherein the light-conducting member 2 has depressions 12 of asymmetrical form about the x-x line. This embodiment is accomplished in such a way that conical or pyramidal depressions of the light-conducting member 2 in the first embodiment of Figure 3 are replaced by those of asymmetrical form. Alternatively, conical or pyramidal projections may be replaced by those of asymmetrical form. Further, regarding the light-conducting member of Figures 11 through 13, symmetrical depressions may be replaced by those of asymmetrical form. Also, regarding the light-conducting member of Figures 15, 16 and 17, projections shown therein may be replaced by those of asymmetrical form.

Figure 18 is a view of a variant of the light-conducting member of Figure 17, wherein a surface 2c of the light-conducting member is of curved form. In the embodiments of Figures 17 and 18, the apexes 12a of the depressions 12 should preferably have curved surfaces.

In the first through seventh embodiments, noted above, the rough surfaces 11 are formed only on depressions or projections of the light-conducting member 2. However, the rough surfaces may be formed in portions between depressions or projections.

Figure 19 is a view of an eighth embodiment of a light-conducting member. In this embodiment, a surface 2c of the light-conducting member 2 has smooth, continuous corrugations in all the directions along its surface. Figure 19 is a sectional view of the light-conducting member taken in a direction of the arrow A-A of Figure 20, which is a plan view of the member as viewed from its top. The section of the surface 2c in a direction of an arrow B-B, which is at right angles to the direction of the arrow A-A, is also of corrugation. Further, the section of the surface 2c in an oblique direction of the arrow C-C, set at an angle to the directions of the arrows A-A and B-B, has also a corrugated one.

In this eighth embodiment, the light that is directed onto the incidence surface 2a of the light-conducting member 2 is totally reflected from the surfaces 2b and 2c as it travels toward the surface 2d. While traveling toward the surface 2d, the light is totally reflected in different directions by the provision of corrugations. Also, part of the light is refracted by,and transmitted through, the corrugations.

The transmitted light is reflected by the reflective plate 4 and, after having been refracted by the corrugations, it re-enters into the light-conducting member 2 passing through the corrugations. Thus, a diffused light, i.e., the light that has emitted through the surface 2b and then passed through the diffusion plate 3 will appear substantially uniform and in large amounts on the diffusion plate 3. The diffused light thus obtained is so uniform that there occurs no bright spots at all.

In this embodiment, to provide a more uniform light on the diffusion plate 3, it will be effective that the corrugations have rough surfaces.

In this embodiment, there occurs no bright spots at all because the surface 2c of the light-conducting member 2 has continuous corrugations in all directions, as noted above. Further, it is relatively easy to provide rough surfaces for the corrugations.

Corrugations of Figure 19 may be changed with respect to their size and shape etc. Figures 21 and 22 are views of the corrugation shape. The corrugation shape of Figure 21 may be altered with respect to its various dimensions, such as height h, spacing between adjacent corrugations f, and incline of slope g, that is, angle θ of Figure 22.

Figures 23 through 27 are views of variants of a light-conducting member for use in an eighth embodiemnt of this invention, wherein corrugations of different sizes and shapes etc. are provided in different locations.

The light-conducting member 2 of Figure 23 has corrugations with an increased height as they lie farther from the light source. Thus, a light is uniformly emitted through the surface 2b of the light-conducting member 2.

In the light-conducting member 2 of Figure 24, the surface 2c has corrugations with an decreased spacing between adjacent corrugations as they lie farther from the light source. Thus, as in Figure 23, a light is allowed to be uniformly emitted through the surface 2b of the light-conducting member 2.

The light-conducting member 2 of Figure 25 is intended for use in a surface light source device, wherein a pair of light sources 1 are placed adjacent both edge surfaces 2a and 2d of the light-conducting member 2. The surface 2c of the light-conducting member 2 has corrugations in such a way that their height at both edge surfaces 2a and 2d, is the lowest and it is the highest at the center of the light-conducting member 2.

In the light-conducting member 2 of Figure 26, the surface 2c has corrugations with an increased angle θ of the slope g as they lie farther from the light source. The angle θ at the edge surface 2d is 45° to 60°.

The light-conducting member 2 of Figure 27 has an edge surface 2d opposite to an edge surface of incidence 2a, and the edge surface acts as a reflective surface. The light that is directed onto the edge surface 2a is reflected back from the opposite edge surface 2d after having reaching it. The light will not escape through the edge surface 2d. As a result, the region adjacent to a reflective plate 7 shines brightly and thus it is impossible to provide a uniform brightness distribution. To provide a uniform brightness, the light-conducting member 2 of Figure 27 has a surface 2c formed with corrugations in such way that their height is the lowest for those close to the edge surface 2a and it becomes gradually higher as they lie farther away from the edge surface 2a, and then their height becomes lower toward the edge surface 2d.

The light-conducting member 2 of Figure 28 is tapered in thickness. It has a thickest portion close to the light source and has an decreased thickness along its length. The tapered surface 2c has corrugations.

The light-conducting member 2 of Figure 29 is tapered in thickness toward its center where it has a thinnest portion. A pair of light sources are positioned adjacent opposite edge surfaces of the light-conducting member 2. A lower surface 2c has corrugations.

In the light-conducting member of Figures 23 to 29, noted above, it is possible to provide the corrugations with rough surfaces.

Now, description will be made on means to form rough surfaces on a surface 2c of the light-conducting member in the first through eighth embodiments. The light-conducting member is generally made of transparent synthetic resins. Thus, a mold used in molding the light-conducting member of synthetic resins should have rough surfaces.

To form rough surfaces on the mold, an electric-discharge machining (a spark erosion process) may be used for this invention. As a typical example, a light-conducting member 2 requires to have a pattern with a multiplicity of tiny spots 16, as shown in Figure 31. The mold is prepared by a spark erosion process to form a corresponding pattern of spots.

In this process, as shown in Figure 30, an electrode 17 is maintained very close to a mold 15. The electrode 17 of male form has a large number of projections 17a that correspond to tiny spots 16 in Figure 31. As shown in Figure 30, the mold 15 and electrode 17 are positioned in opposed relation. The mold 15 is made to act as the other electrode so that the electric-spark machining is carried out. In this way, a surface 15a of the mold 15 which is placed very close to the electrode 17 will be machined in areas facing the projections 17a of the electrode 17 to form a desired pattern of the roughness on the rough surfaces. Typically, the electric-spark machining is made with the current of 3-7 A, and at a pulse duration of 5-20 microseconds. By changing the operating conditions of the electric-spark machining process, it is possible to provide different patterns of the roughness on the rough surfaces.

When a multiplicity of dots are formed on the projections or depressions of the rear surface 2c of the light conductive member 2 by printing in place of providing the rough surface on them, the extent of the diffusion of the scattered light is substantially the same as in the later ease. The fact that a number of the dots per unit area is great corresponds to that the roughness of the rough surface is great.

Important aspects of the described invention are as follows:

A surface light source device which comprises a light-conducting member consisting of a sheet of transparent material, a linear light source disposed adjacent to an edge surface of the light-conducting member, a diffusion plate disposed on a front surface of the light-conducting member and a reflective plate disposed on a rear side of the light-conducting member. The rear surface of the light-conducting member has depressions or projections. These depressions or projections have rough surfaces. By selecting the shape of the depressions or projections, and controlling the roughness of the rough surfaces, an enhanced uniform brightness distribution is provided.

Claims

1. A surface light source device comprising a light-conducting member consisting of a sheet of transparent material, a linear light source disposed adjacent to an edge surface of incidence of said light-conducting member, a diffusion plate disposed on a front surface of said light-conducting member therealong, and a reflective surface disposed on a surface of said light-conducting member therealong opposite said diffusion plate, said light-conducting member comprising a multiplicity of tiny depressions formed on said surface adjacent to said reflective surface and said depressions having rough surfaces.

2. The surface light source device of claim 1 wherein said tiny depressions are of conical shape.

3. The surface light source device of claim 1 wherein said tiny depressions are of pyramidal form.

4. The surface light source device of claim 1 wherein said tiny depressions are of hemispherical form and have an increased size as they lie farther from said edge surface of incidence, with depressions of the smallest size being disposed close to said edge surface of incidence.

5. The surface light source device of claim 1 wherein said tiny depressions are of cylindrical shape and have an increased size as they lie farther from said edge surface of incidence, with depressions of the smallest size being disposed close to said edge surface of incidence.

6. The surface light source device of claim 5 wherein the innermost surface of said tiny depressions has a spherical form.

7. A surface light source device comprising a light-conducting member consisting of a sheet of transparent material, a linear light source disposed adjacent to an edge surface of incidence of said light-conducting member, a diffusion plate disposed on a front surface of said light-conducting member therealong, and a reflective surface disposed on a surface of said light-conducting member therealong opposite said diffusion plate, said member comprising a multiplicity of tiny projections formed on said surface adjacent to said reflective surface.

8. The surface light source device of claim 7 wherein said projections have a hemispherical shape.

9. The surface light source device of claim 7 wherein said projections have a cylindrical shape.

10. The surface light source device of claim 9 wherein said projections have a curved tip.

11. The surface light source device of any of claims 8, 9 and 10 wherein said projections have an increased size as they lie farther from said edge surface of incidence with the smallest projections lying close to said edge surface of incidence.

12. The surface light source device of claim 1 wherein said depressions are identically shaped and sized and equally spaced and wherein said depressions have rough surfaces and the roughness of said rough surfaces become greater as they lie farther from said edge surface of incidence.

13. The surface light source device of claim 1 wherein said depressions are identically shaped and wherein said depressions become larger as they lie farther from said edge surface of incidence with the largest depressions lying close to said edge surface of incidence.

14. The surface light source device of claim 1 wherein said depressions have an identical depth, but said depressions have an increased diameter as they lie farther from said edge surface of incidence with the depressions of the smallest breadth lying close to said edge surface of incidence, and wherein said depressions have rough surfaces.

15. The surface light source device of claim 1 wherein said depressions have an identical diameter, but said depressions have an increased depth as they lie farther from said edge surface of incidence with the depressions of the smallest depth lying close to said edge surface of incidence.

16. The surface light source device of claim 7 wherein said projections are identically shaped and sized and equally spaced and wherein said projections have rough surfaces and the roughness of said rough surfaces become greater as they lie farther from said edge surface of incidence.

17. The surface light source device of claim 7 wherein said projections have an identical diameter, but have an decreased height along the length of said light-conducting member with the lowest projections lying close to said edge surface of incidence.

18. The surface light source device of claim 7 wherein said projections have an identical height, but have an increased diameter along the length of said light-conducting member with the projections of the smallest diameter lying close to said edge surface of incidence.

19. The surface light source device of any of claims 13, 14, 15, 17 and 18 wherein the roughness of said rough surfaces become greater as they lie farther from said edge surface of incidence.

20. A surface light source device comprising a linear light source, a light-conducting member having an edge surface of incidence disposed adjacent to said light source, a diffusion plate disposed on the front surface of said light-conducting member therealong, and a reflective surface disposed on a surface of said light-conducting member opposite to said diffusion plate, said device comprising a multiplicity of corrugations formed on said suface of said light-conducting member close to said reflective surface, said corrugations having either curved surfaces or a combination of curved and planar surfaces continuously formed in all directions, and said corrugations having rough surfaces.

21. The surface light source device of claim 20 wherein said curved surfaces have an increased height as they lie farther from said edge surface of incidence, with the lowest ones lying adjacent to said edge surface of incidence.

22. The surface light source device of claim 20 wherein said corrugations have an decreased wavelength as they lies farther from said edge surface of incidence and the ones with the largest wavelength lying close to said edge surface of incidence.

23. The surface light source device of claim 20 wherein said corrugations have an increased or decreased incline between a crest and a base of a waveform as they lie farther from said edge surface of incidence, in such a way that the incline is about 45° to 60° for the corrugations lying at the farthest position.

24. The surface light source device of claim 20 wherein the roughness of said rough surfaces become greater as they lie farther from said edge surface of incidence.

25. The surface light source device of claim 20 wherein said corrugations have variations by appropriately selecting and changing two or more factors comprising a height, wavelength, incline between a crest and base of a waveform as well as the roughness of said rough surfaces.

26. A surface light source device comprising a linear light source, a light-conducting member having an edge surface of incidence disposed adjacent to said light source, a light-reflective member placed on a surface of said light-conducting member opposite to said edge surface of incidence, a diffusion plate disposed on an emitting surface of said light-conducting member, and a reflective surface of said light-conducting member, said device comprising corrugations formed on said reflective surface of said light-conducting member, said corrugations having either curved surfaces or a combination of curved and planar surfaces continuously formed in all directions, said corrugations having rough surfaces and said corrugations having an increased height with the lowest ones lying close to said edge surface of incidence, and again becoming lower toward said light-reflective member.

27. A surface light source device comprising a linear light source, a light-conducting member having an edge surface of incidence disposed adjacent to said light source, a light-reflective member placed on a surface of said light-conducting member opposite to said edge surface of incidence, a diffusion plate disposed on an emitting surface of said light-conducting member, and a reflective surface of said light-conducting member, said device comprising corrugations formed on said reflective surface of said light-conducting member, said corrugations having either curved surfaces or a combination of curved and planar surfaces continuously formed in all directions, said corrugations having rough surfaces, and said corrugations having a decreased wavelength as the ones having the largest wavelength lie close to said edge surface of incidence, and again becoming larger toward said light-reflective member.

28. A surface light source device comprising a linear light source, a light-conducting member having an edge surface of incidence disposed

adjacent to said light source, a light-reflective member placed on a surface of said light-conducting member opposite to said edge surface of incidence, a diffusion plate disposed on an emitting surface of said light-conducting member, and a reflective surface disposed on a surface of said light-conducting member opposite to said diffusion plate, said device comprising corrugations formed on said reflective surface of said light-conducting member, said corrugations having an increased or decreased incline between a crest and a base of a waveform, approaching 45° to 60° and after attaining 45° to 60°, increasing or decreasing toward said light-reflective member so as to deviate from an angle less than 45° to 60°.

29. A surface light source device comprising a linear light source, a light-conducting member having an edge surface of incidence disposed adjacent to said light source, a light-reflective member placed on a surface of said light-conducting member opposite to said edge surface of incidence, a diffusion plate disposed on an emitting surface of said light-conducting member, and a reflective surface disposed on a surface of said light-conducting member opposite to said diffusion plate, said device comprising corrugations formed on said reflective surface of said light-conducting member, said corrugations having rough surfaces, and the roughness of said rough surfaces becoming greater as they lie farther from said edge surface of incidence, again being smaller toward said light-reflective member.

30. A surface light source device comprising a linear light source, a light-conducting member having an edge of incidence disposed adjacent to said light source, a light-reflective member placed on a surface of said light-conducting member opposite to said edge of incidence, a diffusion plate disposed on an emitting surface of said light-conducting member, and a reflective surface of said light-conducting member, said device comprising corrugations formed on said reflective surface of said light-conducting member, said corrugations having variations by appropriately selecting and changing two or more factors comprising a height, wavelength, incline between a crest and base of a waveform as well as the roughness of a rough surfaces.

31. The surface light source device of claim 11 wherein said rough surfaces are produced by an electric-discharge machining process.

32. The surface light source device of claim 19 wherein said rough surfaces are produced by an electric-discharge machining process.

33. The surface light source device of any of claims 20 to 29 wherein said rough surfaces are produced by an electric-discharge machining process.

34. The surface light source device of any of claims 7 to 10 wherein said depressions have surface irregularities.

35. The surface light source device of claim 34 wherein said rough surfaces are produced by an electric-discharge machining process.

36. The surface light source device of claim 1 wherein said light-conducting member has a decreased thickness along its length with its thickest portion lying close to said lighting source.

37. The surface light source device of claim 1 wherein a pair of light sources are disposed adjacent to the opposed ends of said light-conducting member and wherein said light-conducting member has depressions formed on its surface close to said reflective surface.

38. The surface light source device of claim 1 wherein said light source is disposed close to each of four sides of said light-conducting member and wherein said light-conducting member has depressions formed on its surface close to said reflective surface.

39. The surface light source device of any of claims 37 and 38 wherein said light-conducting member has a decreased thickness toward its center and said depressions are disposed in a corresponding incline.

FIG. 1 PRIOR ART

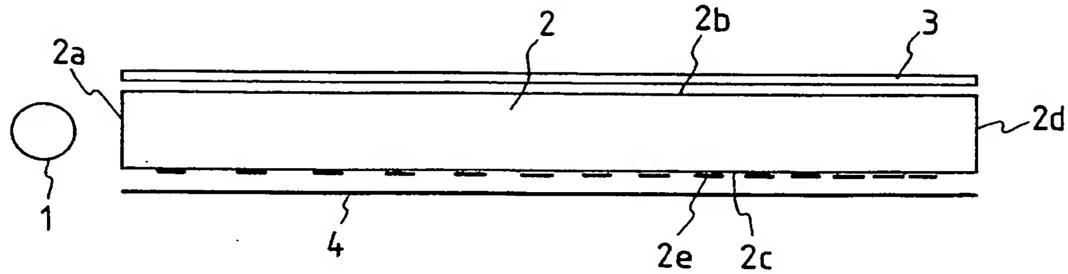


FIG. 2

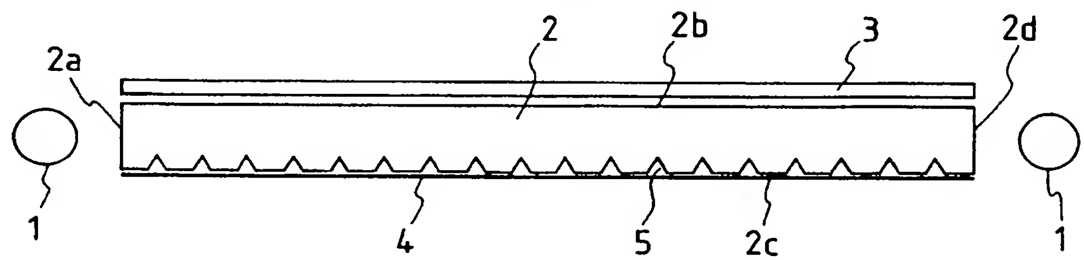


FIG. 3

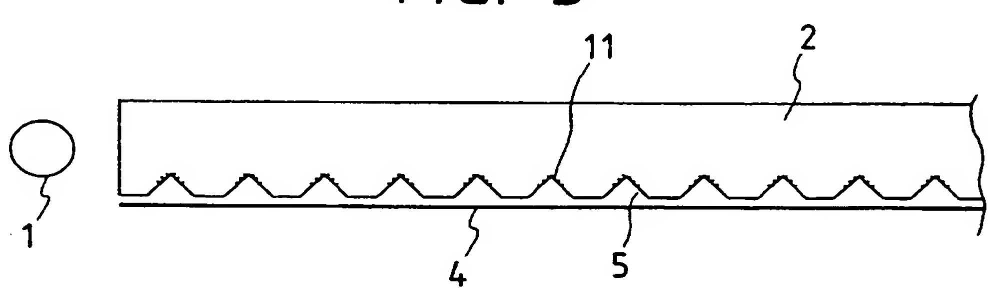


FIG. 4

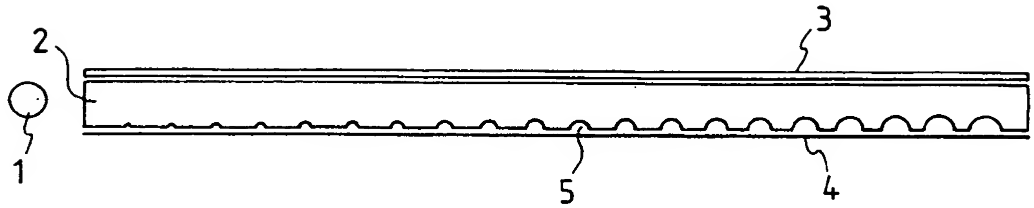


FIG. 5

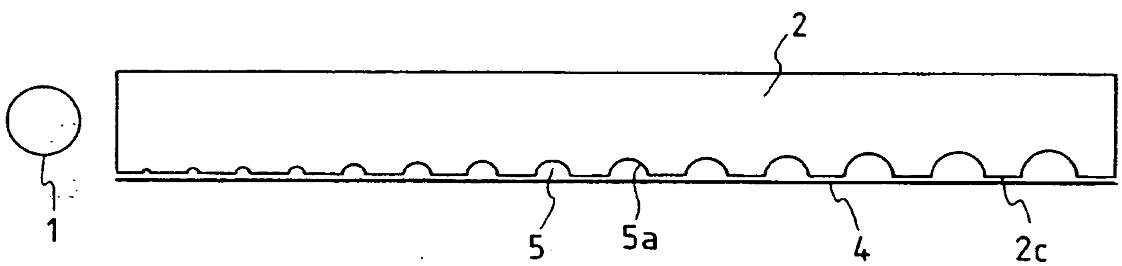


FIG. 6

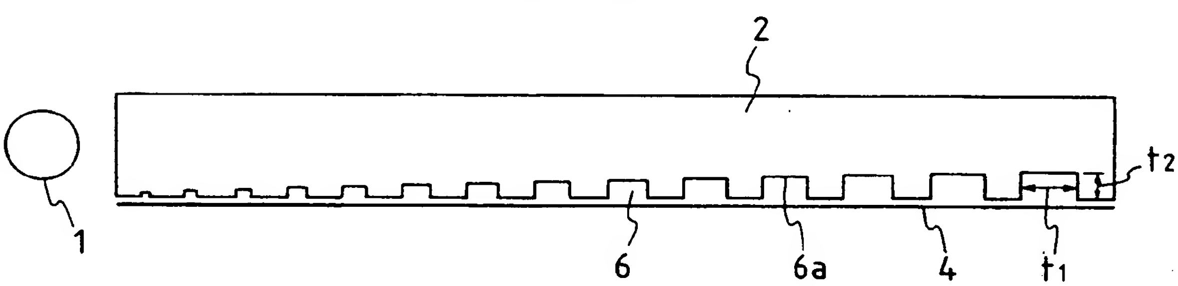


FIG. 7

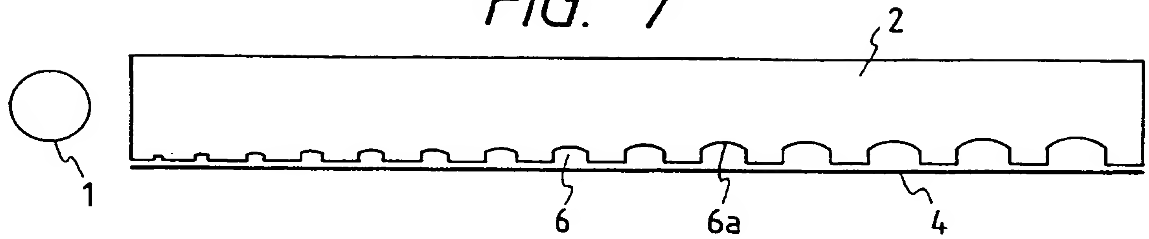


FIG. 8

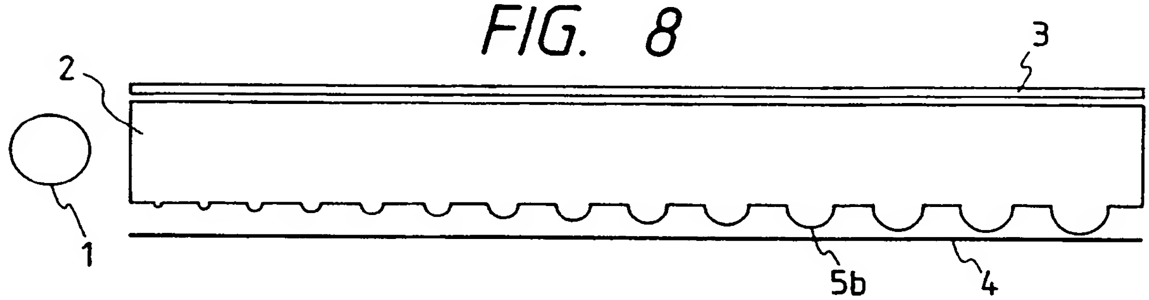


FIG. 9

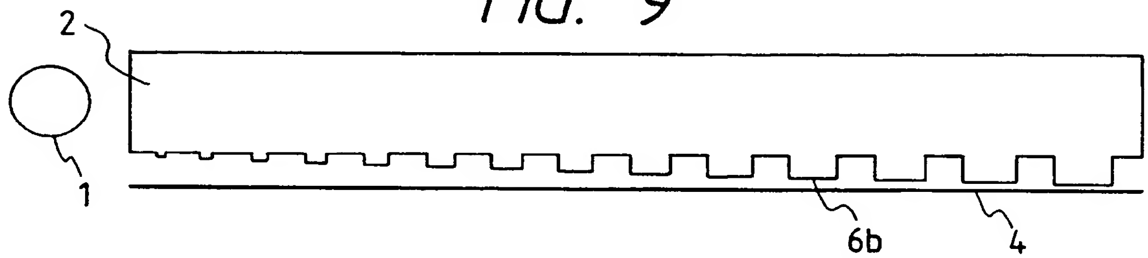


FIG. 10

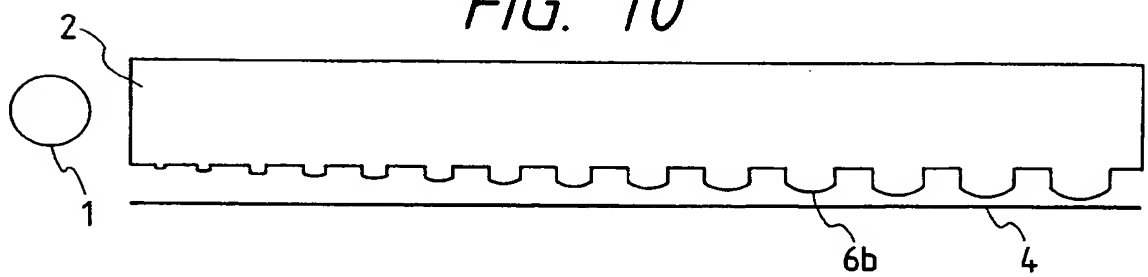


FIG. 11

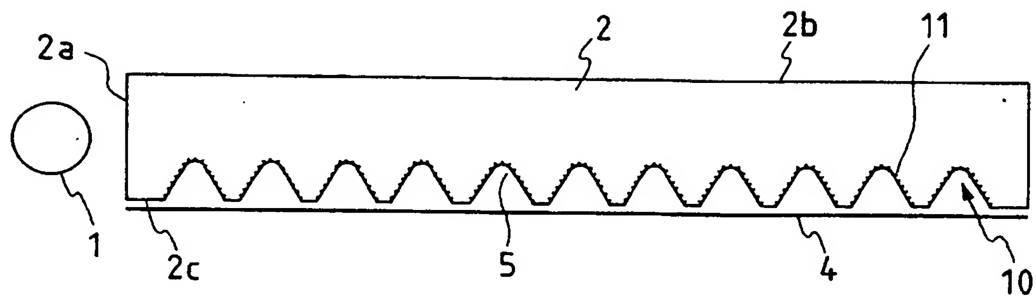


FIG. 12

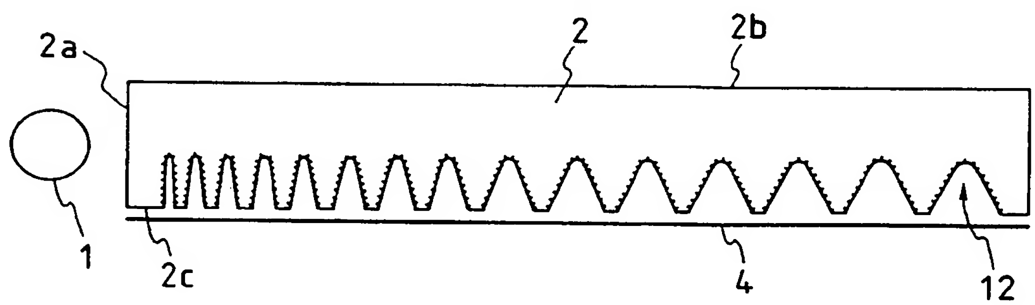


FIG. 13

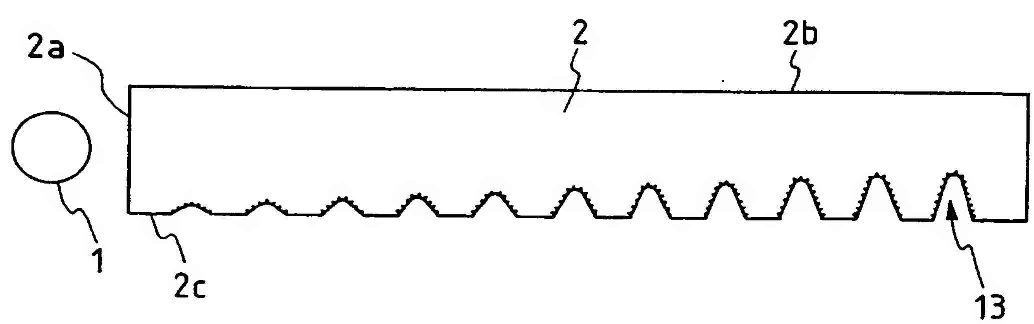


FIG. 14

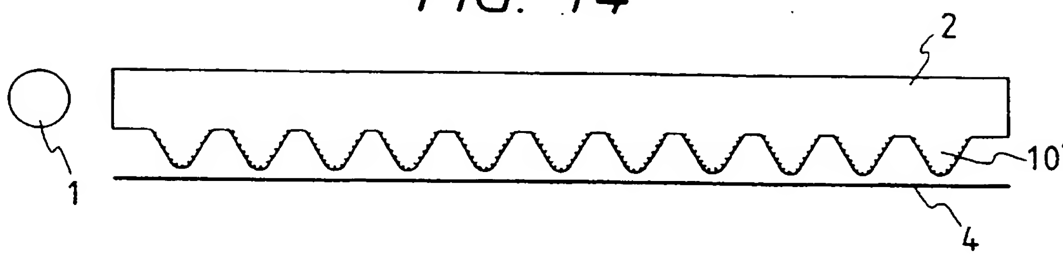


FIG. 15

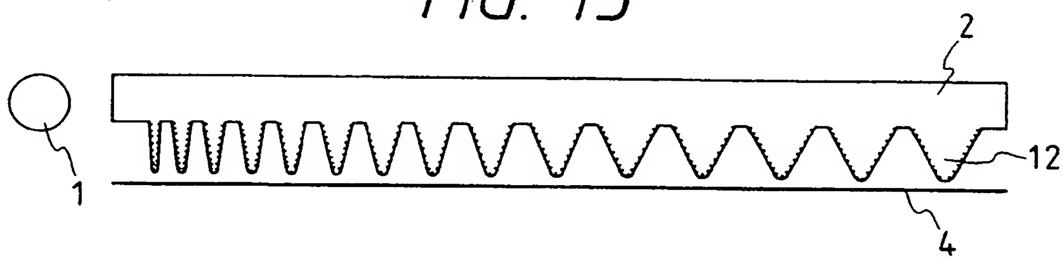


FIG. 16

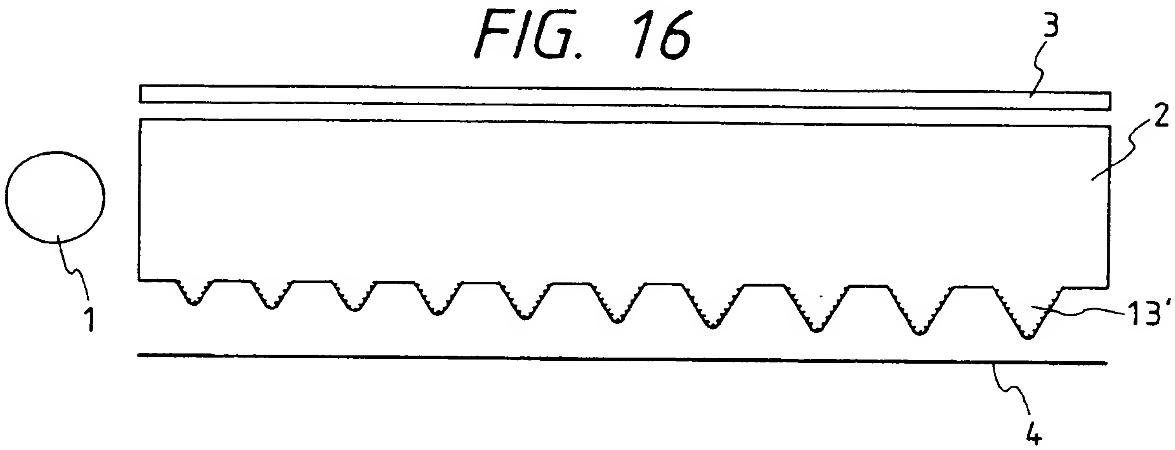


FIG. 17

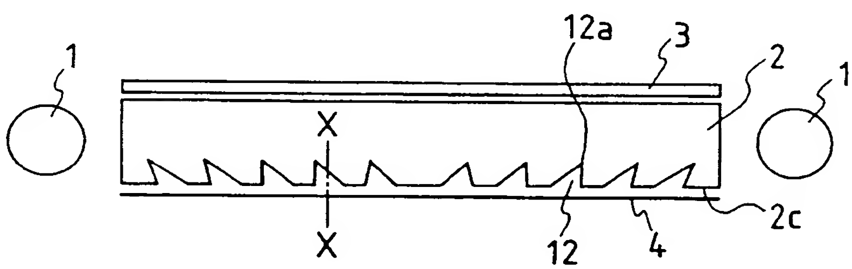


FIG. 18

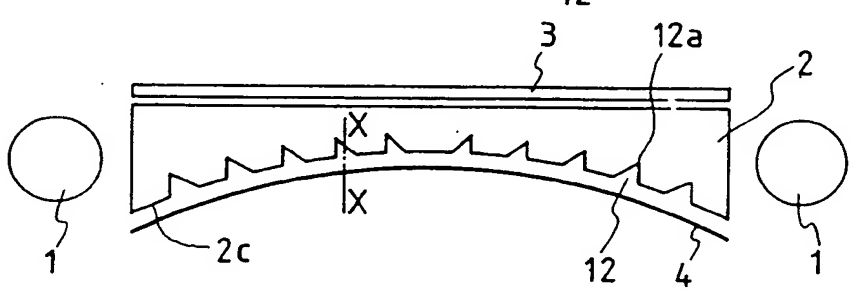


FIG. 19

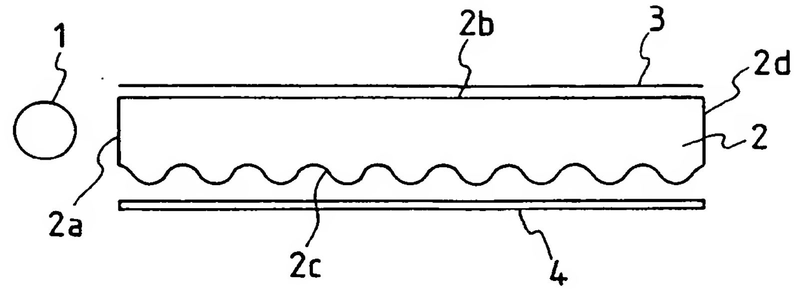


FIG. 20

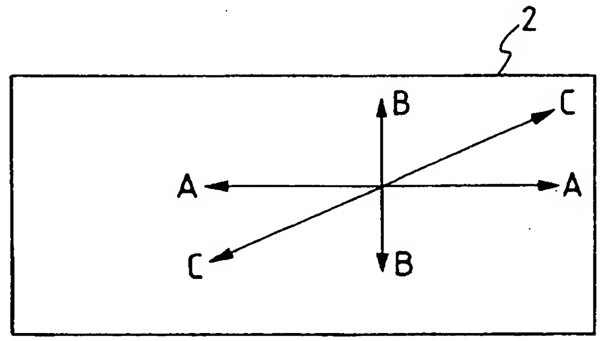


FIG. 21

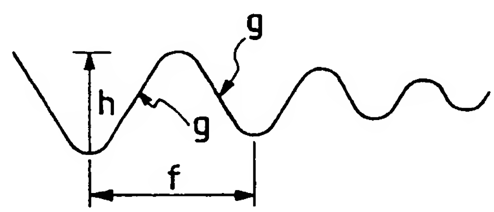


FIG. 22

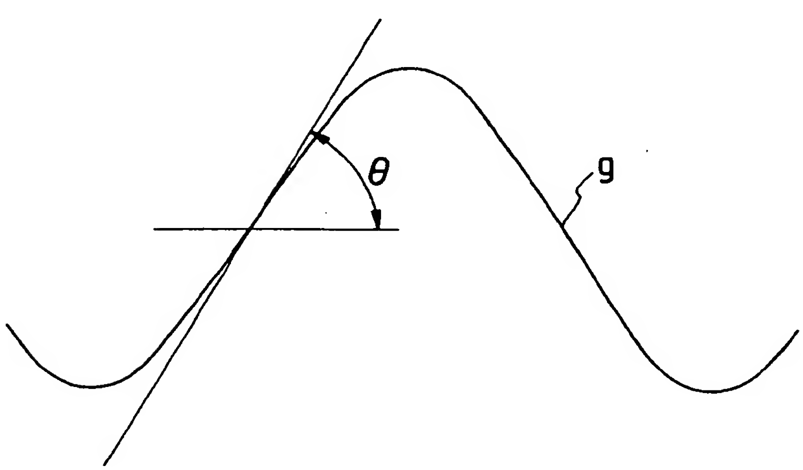


FIG. 23

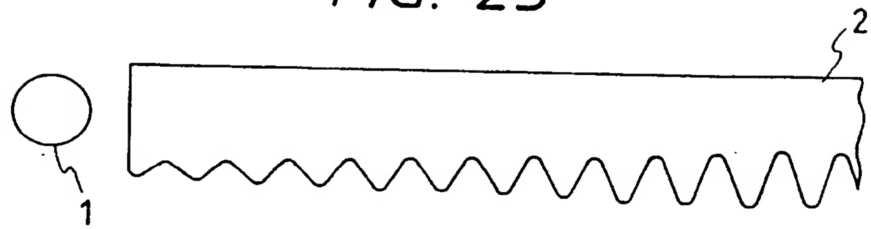


FIG. 24

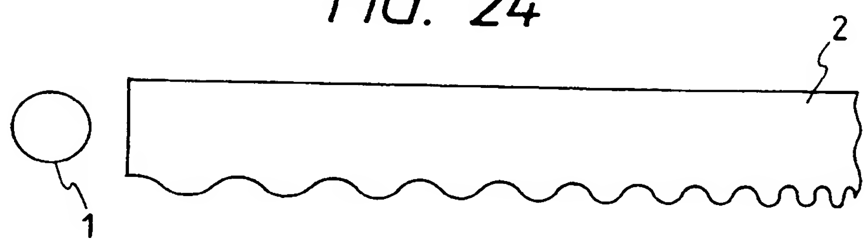


FIG. 25

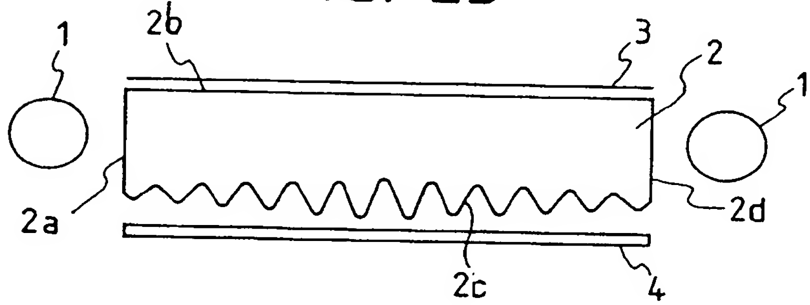


FIG. 26

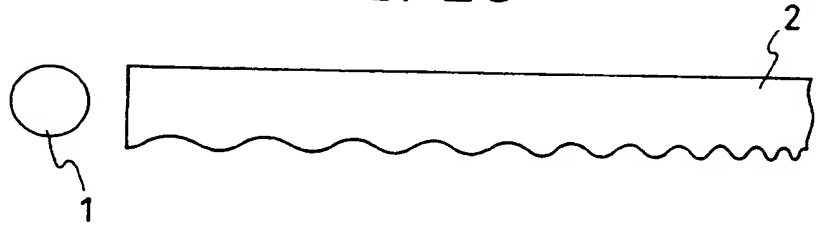


FIG. 27

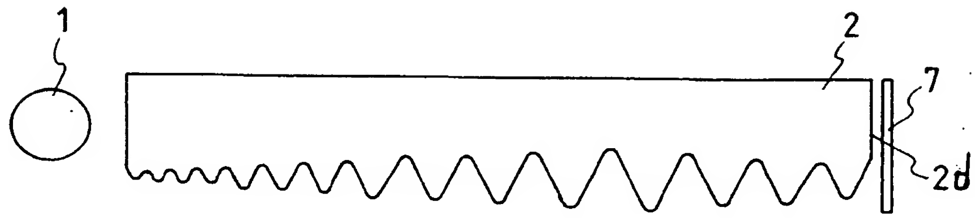


FIG. 28

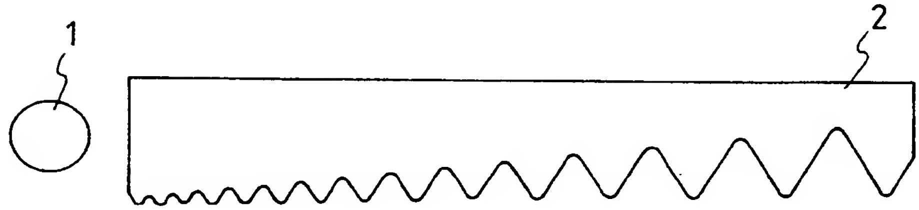


FIG. 29

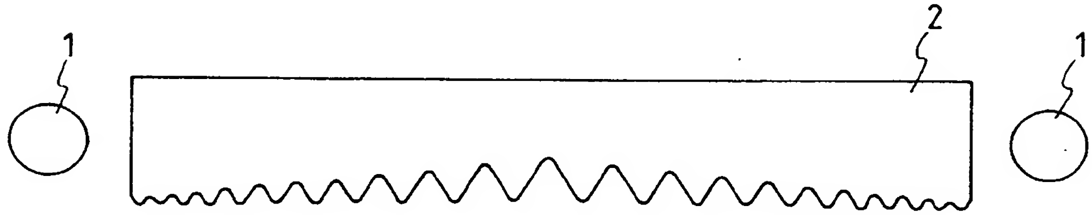


FIG. 30

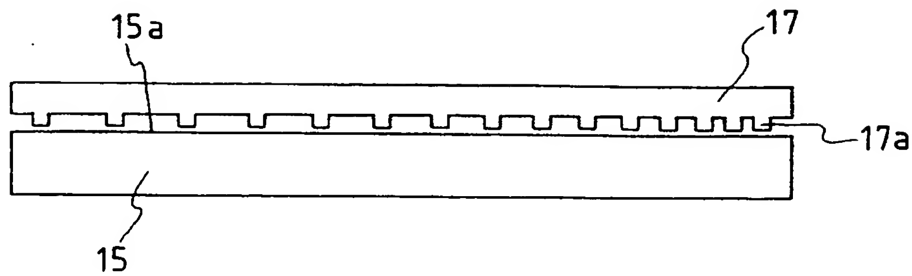
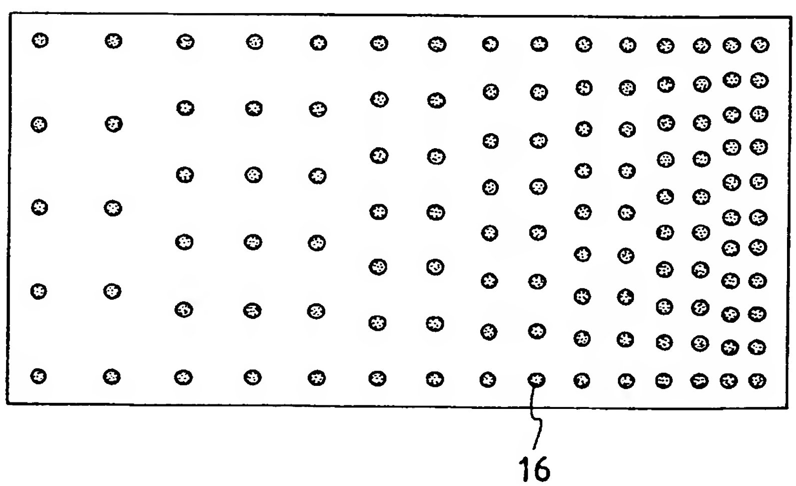


FIG. 31



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Application Number

EP 92 12 0336
Page 1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	US-A-5 005 108 (PRISTASH ET AL.)	1,3,4,7, 34,36	G02F1/1335 F21V8/00
Y		2,8, 11-22, 26,27, 29,37,38	
A		5,6,9, 10,23, 25,28, 30, 31-33, 35,39	
	* column 1, line 19 - column 2, line 20; claims; figures * * column 4, line 57 - column 5, line 5 * ---		
Y	PATENT ABSTRACTS OF JAPAN vol. 15, no. 119 (P-1183)22 March 1991 & JP-A-30 09 306 (MITSUBISHI) 17 January 1991	2,8,11, 14,15, 17,18	
A	* abstract * ---	5,6,9,10	TECHNICAL FIELDS SEARCHED (Int. Cl.5)
Y	US-A-5 057 974 (MIZOBE)	12,16, 19,29	G02F F21V
A	* abstract * * claim 1; figure 2 * ---	24,25,30	
Y	DE-A-3 313 288 (BOSCH)	13, 20-22, 26,27	
A	* page 5, paragraph 4 - page 7, paragraph 1; claims * --- -/--	15,25,30	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 FEBRUARY 1993	G. Lipp

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Application Number

EP 92 12 0336
Page 2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	FR-A-2 632 432 (SA GUY DARIC) * abstract * * figures * -----	37,38	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)

The present search report has been drawn up for all claims

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THE HAGUE	16 FEBRUARY 1993	G. Lipp

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